Sergio A Guazzotti[3] (serad@chem.ucsd.edu)

Kimberly A Prather[3] (kprather@chem.ucsd.edu)

[1]School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA 30332-0340, United States

[2]Arizona State University, P.O. Box 876106, Tempe, AZ 85287, United States

[3]Department of Chemistry and Biochemistry, University of California, La Jolla, CA 92093, United States

Better understanding of diverse effects of atmospheric aerosols on climate and atmospheric chemistry requires more realistic treatments of physical and chemical properties of aerosol particles. Recent measurements demonstrate that a large fraction of aerosol particles has complex chemical composition and exhibits a variety of shapes. This paper presents new techniques for predicting the optical properties of nonspherical multicomponent aerosols containing mineral dust and/or black carbon. The strategy is to incorporate the statistical information on size-resolved composition and morphology of individual aerosol particles to predict the probability distribution of their main optical characteristics. The techniques were applied to the data provided by the aerosol time-of-flight mass spectroscopy and electronic microscopy. The predicted optical models were then used in calculations of the radiative impact of aerosols under different atmospheric conditions. Similar radiative transfer calculations were performed using a standard approach, by applying Mie theory to an ensample of spherical particles with a lognormal particle size distribution and effective refractive indices. We will address the differences in the radiative effects predicted with both approaches. Also the advantage/disadvantage of both methods will be discussed.

A21G-06 1150h

Measurement and modeling of vertically resolved aerosol optical properties and radiative fluxes over the ARM SGP site

B. Schmid[1]; W. P. Arnott[2]; A. Bucholtz[3]; P. Colarco[4]; D. Covert[5]; J. Eilers[6]; R. Elleman[5]; R. Ferrare[7]; R. Flagan[8]; H. Jonsson[9]; P. Pilewskie[6]; J. Pommier[1]; J. Redemann[1]; K. Ricci[1]; T. Rissman[8]; J. Seinfeld[8]; A. Strawa[6]; T. VanReken[8]; J. Wang[10]; E. J. Welton[11]

[1]Bay Area Environmental Research Institute, 3rd St. West, Sonoma, CA 95476

[2]Desert Research Institute, Raggio Parkway, Reno, NV 89512

[3]Naval Research Lab, Grace Hopper Ave, Monterey, CA 93943

[4]GEST, NASA GSFC, Greenbelt, MD 20771

[5]University of Washington, Atmospheric Sciences, Seattle, WA 98195

[6]NASA, ARC, Moffett Field, CA 94035

[7]NASA, Langley, Hampton, VA 23681

[8]California Institute of Technology, Chemical Engineering, Pasadena, CA 91125

[9]CIRPAS, Imjin Rd, Marina, CA 93933

[10]Brookhaven, National Lab, Upton, NY 11973

[11]NASA, GSFC, Greenbelt, MD 20771

In order to meet one of its goals - to relate observations of radiative fluxes and radiances to the atmospheric composition - the Department of Energy's Atmospheric Radiation Measurement (ARM) program has pursued measurements and modeling activities that attempt to determine how aerosols impact atmospheric radiative transfer, both directly and indirectly. However, significant discrepancies between aerosol properties measured in situ or remotely remain. One of the objectives of the Aerosol Intensive Operational Period (IOP) conducted by ARM in May 2003 at the ARM Southern Great Plains (SGP) site in north central Oklahoma was to examine and hopefully reduce these differences. The IOP involved airborne measurements from two airplanes over the heavily instrumented SGP site. We give an overview of airborne results obtained aboard the Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS) Twin Otter aircraft. The Twin Otter performed 16 research flights over the SGP site. The aircraft carried instrumentation to perform in-situ measurements of aerosol absorption, scattering, extinction and particle size. This included such novel techniques as the photoacoustic and cavity ring-down methods for in-situ absorption (675 nm) and extinction (675 and 1550 nm) and a new multiwavelength, filter-based absorption photometer (467, 530, 660 nm). A newly developed instrument measured cloud condensation nucleus concentration (CCN) concentrations at two supersaturation levels. Aerosol optical depth and extinction (354-2139 nm) were measured with the NASA Ames Airborne Tracking 14-channel sunphotometer. Furthermore, up- and downwelling solar (broadband and spectral) and infrared radiation were measured using seven individual radiometers. Three up-looking radiometers were mounted on a newly developed stabilized platform, keeping the instruments level up to aircraft pitch and roll angles of $\sim 10^{\circ}$. This resulted in unprecedented continuous vertical profiles of radiative fluxes, which we will compare to modeled fluxes using the aforementioned data as input. We will also present comparisons of the vertically resolved aerosol optical properties measured aboard the Twin Otter and from two ground-based lidar systems. Finally we use a trajectory model and a three-dimensional aerosol transport and microphysics model to explore the long-range transport and evolution of smoke aerosols from Siberian fires observed over SGP May 25-28, 2003.

A21G-07 1205h

Source Fluxes of Remote Oceanic Aerosol: Ultrafine Sea-Salt, Sulfates and Clouds

Antony D Clarke (808-956-6215; tclarke@soest.hawaii.edu)

University of Hawaii, School of Ocean and Earth Science and Technology, 1000 Pope Rd., MSB500, Honolulu, HI 96822, United States

We have characterized particles produced from oceanic breaking waves that have diameters as small as 0.01 μm with peak number concentrations between 0.02-0.06 μm. Typically 60% are formed below 0.1 μm, about an order of magnitude smaller than previously documented for oceanic sea-salt. Their stability upon heating implies they are sea-salt nuclei and evolve from an externally mixed to internally mixed aerosol in the marine boundary layer. This production from breaking bubbles and the highly nonlinear dependence of bubble production on wind speed implies strong regional and temporal differences in their surface flux. The comparative strength of this flux to the flux of sulfate aerosol, often entrained into the marine boundary layer from the free troposphere, is critical to their relative role as atmospheric condensation nuclei and cloud condensation nuclei, CCN. Their relative contribution to CCN is expected to be regionally variable ranging from less than 10% to more than 90% of marine boundary layer CCN. Here we show that their size and flux can have significant impact on the origin and evolution of marine boundary layer aerosol under diverse conditions.

A22A MCC: Level 2 Tuesday 1330h

Tropical Cirrus Anvils: Properties and Processes IV Posters *(joint with SA, AE)*

Presiding: **E Jensen,** NASA Ames Research Center**; D E Anderson,** NASA Headquarters

A22A-1035 1330h POSTER

Anvil Discontinuities: Observations Of Kelvin-Helmholts Instabilities In Florida Convection Anvils

Jacob Petre[1] (jmp320@psu.edu)

Robert Carver[1] (carver@mail.meteo.psu.edu)

Johannes Verlinde[1] (verlinde@ems.psu.edu)

[1]Dept. of Meteorology Penn State University, 502 Walker Building, University Park, PA 16803

High spatial and temporal observations from a profiling cloud radar reveal sharp shear/density boundaries in the interior of Florida convective anvils. These discontinuities where seen at all multiple levels within the anvil, lasting for periods of 15 minutes up to several hours. These discontinuity layers effectively divided the anvil into layers with distinct characteristics, and suggest different source regions for the different layers. The most prominent of these discontinuities lasted for approximately 4 hours. At times this layer exhibited clear Kelvin-Helmholtz instability breaking waves.

A22A-1036 1330h POSTER

Simultaneous Remote Sensing of Thin Cirrus and Aerosol Properties from MODIS Data

John K Roskovensky[1] ((310)206-0377; jrosko@atmos.ucla.edu)

Kuo-Nan Liou[1] ((310)825-5039; knliou@atmos.ucla.edu)

[1]University Of California, Los Angeles, Department of Atmospheric Sciences, 7127 Math Sciences, Box 951565, Los Angeles, CA 90095-1565, United States

Tropospheric aerosols and high-level thin cirrus frequently coexist and affect the atmospheric radiation budget and vertical heating rate distribution in different manners associated with their unique optical properties and altitude. However, distinguishing between these two from satellites is extremely difficult because both are optically thin with optical depths generally less than about 0.5. Presently, retrieval of such information as optical thickness and effective particle size by satellite sensors is made separately. That is, aerosols are only examined in presumed clear sky situations while thin cirrus properties are retrieved while assuming a background aerosol size distribution. There is evidence that thin/sub-visible cirrus may exist in greater quantity, especially in the tropics, than is currently being detected, which, in turn, has been leading to large errors in the retrieved aerosol properties. By using new satellite sensors with a greater number of channels and higher spectral resolution, new information is now available which may make it possible to obtain a more accurate estimate of both thin cirrus and aerosol optical properties when they occur in the same field of view. We have developed a procedure to retrieve thin cirrus and aerosol optical depth, as well as cirrus ice crystal effective size, using six Moderate Resolution Imaging Spectroradiometer (MODIS) channels. Theoretical simulations show that these particular channels are sensitive to specific aerosol and cirrus properties. Error analysis reveals that the retrieved optical depths are accurate to within 20%, while ice crystal effective sizes lie within twice that of the real value. Case studies taken from CRYSTAL-FACE indicate that our retrievals compare well with both in-situ measurements and other remotely sensed values. This new retrieval method will increase the total area in which aerosol information can be obtained and reduce the effect of thin cirrus contamination.

A22A-1037 1330h POSTER

Morphology of Tropical Cirrus Crystals Derived from Single Particle and Bulk Property Analysis

Graciela B Raga[1] (raga@servidor.unam.mx); Darrel Baumgardner[1] (darrel@servidor.unam.mx); Greg Kok[2] (glkok@dropletmeasurement.com); Bruce Anderson[3] (B.E.Anderson@LaRC.NASA.GOV); Timothy Garrett[4] (tgarrett@met.utah.edu); Elliot Weinstock[5] (weinstock@huarp.harvard.edu); Jessica Smith[5] (jsmith@huarp.harvard.edu)

[1]Universidad Nacional Autonoma de Mexico, Centro de Ciencias de la Atmósfera - UNAM Universidad Nacional Autónoma de México Circuito Exterior s/n, Ciudad Universitaria, Mexico City, DF 04510, Mexico

[2]Droplet Measurement Technologies, 5710B Flatiron Parkway, Boulder, CO 80301, United States

[3]NASA Langley Research Center, Mail Stop 483, Hampton, VA 23681-0001, United States

[4]University of Utah, 135 S 1460 E, Rm 819, Salt Lake City, UT 84112-0110, United States

[5]Harvard University, 40 Oxford Street, Cambridge, MA 02138, United States

The bulk density, surface area, asphericity and fractal dimensions of crystals in tropical cirrus clouds are derived by combining complementary measurement techniques that were employed during the CRYSTAL/FACE experiment in July, 2002. The instruments that are used in this derivation are the Cloud, Aerosol and Precipitation Spectrometer (CAPS) that measures single particle properties, the cloud integrating nephelometer (CIN) that measures ensemble light scattering and the Harvard Total Water (HTW) sensor that measures the vapor concentration of evaporated cloud particles. The asphericity of particles smaller than 50 μm is determined by comparing the forward and backward scattering light spectra that is measured with the CAPS. The ratio of the areas under the forward and back scattering spectra is proportional to the asymmetry factor and can be used in radiative transfer calculations for evaluating the flux of radiation through the cirrus layers. The fractal dimension of ice crystals larger than 200 μm is also derived from the CAPS measurements and is a measure of the crystal "roughness" , related to the surface area and bulk density. The bulk density is estimated from CAPS and HTW measurements by calculating the volume of particles from the measured size distribution and then deriving the bulk density that would give an ice water content comparable to that measured by the HTW. The evaluation produces a family of curves relating ice crystal effective diameter and bulk density to ice water content. The behavior of these curves under different temperature conditions provides information on the type and age of ice crystals. The ice crystal surface areas are derived in a

similar fashion by comparing the scattering coefficient calculated from the size distributions and direct measurements with the CIN. As with the derivation of bulk density, the surface area computed by this technique depends on the assumed shapes of the crystals. The average fractal dimension, asphericity factor, surface area and bulk density are sensitive to cloud temperature, distance from cloud top and cloud age. Contrail crystals are clearly distinguishable from natural cirrus by much lower fractal dimensions and smaller asphericity.

A22A-1038 1330h POSTER

Cirrus Cloud Optical, Microphysical and Radiative Properties Analyzed from CRYSTAL-FACE Measurements

John M Haynes[1] (970-491-8124; haynes@atmos.colostate.edu)

Cristian Mitrescu[1] (970-491-8670; cristian@atmos.colostate.edu)

Graeme L Stephens[1] (970-491-8541; stephens@atmos.colostate.edu)

[1]Colorado State University, Department of Atmospheric Science, Fort Collins, CO 80523, United States

An important goal of the CRYSTAL-FACE experiment was to derive the radiative budgets of tropical cirrus and determine the factors that affect these budgets. With this goal in mind, we have developed a method of retrieving cloud microphysical properties using combined observations from the airborne Cloud Radar System (CRS) and Cloud Physics Lidar (CPL) operated during CRYSTAL-FACE. This retrieval improves upon more traditional optimal estimation retrieval methods developed by the authors and makes the method more robust and efficient. We apply this method to observations collected during the CRYSTAL-FACE experiment in July 2002. Vertical profiles of visible extinction coefficient, ice crystal diameter, number concentration, and ice water content are retrieved for a series of high and mid-level clouds, including anvils and synoptically forced cirrus, that were observed during multiple flights. These retrieved values are compared against in situ observations, where available, and other retrieval methods. The retrieved cloud properties provide a way of examining the relationships between cirrus microphysics and cirrus optical properties and serve as a basis for the estimation of radiative fluxes and heating rates within the cirrus clouds observed.

A22A-1039 1330h POSTER

Dust transport and deposition observed from the Terra-MODIS space observations

Yoram J Kaufman[1] (301 614 6189; kaufman@climate.gsfc.nasa.gov); Ilan Koren[2]; Didier Tanre[3]; S. Fan[4]; Lorraine Remer[1]; Paul Ginoux[4]

[1]NASA, NASA Goddard Space Flight Center, code 913, Greenbelt, MD 20771, United States

[2]National Research Council, NASA Goddard Space Flight Center, code 913, Greenbelt, MD 20771, United States

[3]Laboratoire d'Optique Atmospherique, CNRS,, Université, de Scie. et Techniq. de Lille,, Villeneuve d'Ascq, VA 59655, France

[4]NOAA GFDL,, Princeton University,, Princeton NJ, United States

Meteorological observations, in situ data and satellite images of dust episodes were used already in the 1970s to estimate that 100 tg of dust are transported from Africa over the Atlantic Ocean every year between June and August and deposited in the Atlantic Ocean and the Americas. Desert dust is a main source of nutrients to oceanic biota and the Amazon forest, but deteriorates air quality and caries pathogens as shown for Florida. Dust affects the Earth radiation budget, thus participating in climate change and feedback mechanisms. There is an urgent need for new tools for quantitative evaluation of the dust distribution, transport and deposition. The Terra spacecraft launched at the dawn of the last millennium provides first systematic well calibrated multispectral measurements from the MODIS instrument, for daily global analysis of aerosol. MODIS data are used here to distinguish dust from smoke and maritime aerosols and evaluate the African dust column concentration, transport and deposition. We found that 230±80 tg of dust are transported annually from Africa to the Atlantic Ocean, 30 tg return to Africa and Europe, 70 tg reach the Caribbean, 45 tg fertilize the Amazon Basin, 4 times as previous estimates thus explaining a paradox regarding the source of nutrition to the Amazon forest, and 120±40 tg are deposited in the Atlantic Ocean. The results are compared favorably with dust transport models for particle radius * 12 μm. This study is a first example of quantitative use of MODIS aerosol for a geophysical study.

A22A-1040 1330h POSTER

Ice Nucleation of Re-Dispersed African Desert Dust Samples

Ottmar Möhler[1] (ottmar.moehler@imk.fzk.de); Martin Schnaiter[1]; Robert Wagner[1]; Claudia Linke[1]; Harald Saathoff[1]; Ulrich Schurath[1]; Alexander Mangold[2]; Martina Kramer[2]

[1]Forschungszentrum Karlsruhe, IMK-AAF, P.O. Box 3640, Karlsruhe 76021, Germany

[2]Forschungszentrum Jülich, ICG-1, P.O. Box, Jülich 52425, Germany

Number concentration and size of ice crystals in upper tropospheric cirrus clouds is result of a competition between homogeneous and heterogeneous freezing processes and the dynamic partitioning of water between the interstitial vapour phase and the ice surface. High updraft velocities as e.g. occurring in convective cloud systems favour the formation of high ice particle concentrations by homogeneous freezing of solution aerosols which requires ice supersaturations of up to 60%. At lower updrafts, however, heterogeneous ice nuclei, e.g aircraft emitted soot particles or particles originating from the lower boundary layer, may selectively be activated at lower supersaturation. The pristine ice crystals grow by water uptake, thus eventually limiting the maximum supersaturation to values below the homogeneous freezing threshold. Recent measurements during Crystal-Face have shown mineral dust particles originating from northern Africa to act as efficient ice nuclei in the middle troposphere. Using the large coolable and evacuable aerosol chamber AIDA (Aerosol Interaction and Dynamics in the Atmosphere) of Forschungszentrum Karlsruhe, we have investigated the freezing thresholds of redispersed African desert dust samples at different cooling rates and temperatures between -40°C and -70°C. The mineral dust particles with diameters between about 0.5 and 2 μm turned out to act as quite effective deposition nuclei at relatively low ice supersaturations. Experimental methods and ice nucleation results will be discussed on the poster. Results from previous AIDA experiments with soot and mineral dust particles coated with sulphuric acid and ammonium sulphate will also be shown.

URL: http://imk-aida.fzk.de

A22A-1041 1330h POSTER

Processing and Transport of Aerosol by Mixed-phase Deep Convection and its Feedback on Cloud Microphysical Properties and Precipitation

Yan Yin (yan@env.leeds.ac.uk)

Ken Carslaw (carslaw@env.leeds.ac.uk)

We have developed a detailed 2-D model of aerosol and gas transport in warm and mixed-phase convective clouds including a full treatment of kinetic processes controlling aerosol-cloud interaction and gas partitioning among size-resolved hydrometeors. Numerical simulations are conducted to understand how the aerosol spectra and chemical composition are modified during the cloud lifetime. Results will be presented from idealised and sensitivity experiments in which low level convective inflow air containing specified aerosol spectra is processed by the modelled convective clouds. Modification of the aerosol spectra in convective outflow by scavenging of aerosol and soluble gases, and by aqueous chemical reactions is diagnosed. The feedback of the cloud-processed aerosols on cloud microphysical properties and precipitation behaviour of the primary cloud will be discussed.

A22A-1042 1330h POSTER

Ice Nucleation by High Molecular Weight Organic Compounds

Will Cantrell[1] (906 487 2356; cantrell@mtu.edu)

Eli Ochshorn (ekochsho@mtu.edu)

[1]Michigan Technological University, Dept. of Physics 1400 Townsend Dr., Houghton, MI 49931, United States

Deep convection in the tropics is frequently associated with biomass burning. Recent work has suggested that the size of ice crystals in the anvils of tropical cumulonimbus clouds may be affected by biomass burning, though the mechanism for such an effect is uncertain (Sherwood, 2002). We will present results of an investigation of the role that high molecular weight organic compounds, known to be produced in biomass burning (Elias et al., 1999), may play in tropical cirrus anvils through heterogeneous nucleation of ice. In particular, we examine the mechanisms underlying heterogeneous nucleation of ice by films of long chain alcohols by studying the interaction of the alcohols and water/ice using temperature controlled, Attenuated Total Reflection - Fourier Transform Infrared spectroscopy. The mechanisms are interpreted in the context of recent criticisms of some aspects of classical nucleation theory (Seeley and Seidler, 2001; Oxtoby, 1998). References V. Elias, B. Simoneit, A. Pereira, J. Cabral, and J. Cardoso, Detection of high molecular weight organic tracers in vegetation smoke samples by high-temperature gas chromatography-mass spectrometry. Environ. Sci. Tecnol., 33, 2369-2376, 1999. D. Oxtoby, Nucleation of first-order phase transitions. Acc. Chem. Res., 31, 91-97, 1998. L. Seeley and G. Seidler, Preactivation in the nucleation of ice by Langmuir films of aliphatic alcohols. J. Chem. Phys., 114, 10464-10470, 2001. S. Sherwood, Aerosols and ice particle size in tropical cumulonimbus. J. Climate, 15, 1051-1063, 2002.

A22A-1043 1330h POSTER

Development of an Algorithm for Studying the Tropical Cirrus Properties From CRYSTAL-FACE Groung-Based Infrared Measurements

Ping Yang[1] (9798454923; pyang@ariel.met.tamu.edu)

Qiang Ji[2] (ji@climate.gsfc.nasa.gov)

Guang Guo[1] (gguo@ariel.met.tamu.edu)

Si-Chee Tsay[2] (tsay@climate.gsfc.nasa.gov)

[1]Texas A&M University, Department of Atmospheric Sciences, TAMU 3150, College Station, TX 77843

[2]NASA Goddard Space Flight Center, Code 913, Greenbelt, MD 20771

The radiation budget, climate change and feedback processes involving clouds are important. In the tropics, the radiative heating/cooling and forcing are strongly modulated by cirrus clouds due to the fact that these clouds occur frequently and ubiquitously. Here we report an algorithm for inferring the microphysical and radiative properties of cirrus clouds (i.e., effective size, ice water path, optical thickness and cloud emissivity) from ground-based high-spectral-resolution infrared observations. This approach is based on the fact that the downward radiance is sensitive to the cloud optical thickness in the 800-1200 cm-1 atmospheric window region. Additionally, the spectral slope of the brightness temperature for the downward radiance is sensitive to both the effective radius of ice crystals and the optical thickness of cirrus clouds. This spectral feature of atmospheric infrared radiation allows us to retrieve three microphysical properties of cirrus clouds simultaneously. In practice, we employ a "curve enveloping" technique to avoid the effect of a "non-absorption band shift". Thirty in-situ size distributions are used to calculate the mean scattering properties of ice crystals in cirrus clouds. The clear sky optical thickness and downward radiance are simulated by a line-by-line radiative transfer model and the discrete-ordinate-method radiative transfer model, respectively. Furthermore, we use sky images and normalized lidar backscatter profiles to identify cloudy and cloud-free conditions. As a case study, we apply the present algorithm to the retrieval of cirrus properties on the basis of the surface infrared spectrum acquired during the Cirrus Regional Study of Tropical Anvils and Cirrus Layers-Florida Area Cirrus Experiment (CRYSTAL-FACE) in July 2002.

A22A-1044 1330h POSTER

Measurements of Ice Water Content in Low-latitude Cirrus Clouds

Linnea M Avallone[1] (303-492-5913; avallone@lasp.colorado.edu)

A. Gannet Hallar[1] (303-735-1849; hallar@lasp.colorado.edu)

[1]Laboratory for Atmospheric and Space Physics, University of Colorado 590 UCB, Boulder, CO 80309-0590, United States

During the CRYSTAL-FACE campaign, ice water content (IWC) was determined on the basis of observations of so-called total water made with a closed-path tunable diode laser hygrometer (CLH). The instrument was configured especially for measurements of thin cirrus, by employing a forward-facing subisokinetic inlet that inertially enhances articulate concentrations by about a factor of 50. The resulting detection limit for IWC is better than 0.05 mg m^{-3} under most conditions. In this presentation, we will describe the CLH instrument performance, illustrate the procedure for determining IWC from the total water observations and discuss the uncertainties in the resulting IWC values. We will show several examples covering the wide range of cirrus IWC observed, from $<$ 0.1 mg m^{-3} to $>$ 1 g m^{-3}, with particular emphasis on the morphology of clouds found near the tropopause.

A22A-1045 1330h POSTER

Nitric Acid Uptake on Subtropical Cirrus Cloud Particles

P. J. Popp[1,2] (303-497-5181; ppopp@al.noaa.gov); R. S. Gao[1] (gao@al.noaa.gov); T. P. Marcy[1,2] (tmarcy@al.noaa.gov); D. W. Fahey[1,2] (fahey@al.noaa.gov); P. K. Hudson[1,2] (phudson@al.noaa.gov); T. L. Thompson[1] (thompson@al.noaa.gov); B. Karcher[3] (bernd.kaercher@dlr.de); B. A. Ridley[4] (ridley@ucar.edu); A. J. Weinheimer[4] (wein@ucar.edu); D. J. Knapp[4] (knapp@ucar.edu); D. D. Montzka[4] (montzka@ucar.edu); D. Baumgardner[5] (darrel@servidor.unam.mx); T. J. Garrett[6] (tgarrett@met.utah.edu); E. M. Weinstock[7] (weinstock@huarp.harvard.edu); J. B. Smith[7] (jsmith@huarp.harvard.edu); D. S. Sayres[7] (dsayres@huarp.harvard.edu); J. V. Pittman[7] (jvellovic@huarp.harvard.edu); S. Dhaniyala[8] (sdhaniya@clarkson.edu); T. P. Bui[9] (pbui@mail.arc.nasa.gov); M. J. Mahoney[10] (Michael.J.Mahoney@jpl.nasa.gov)

[1]Aeronomy Laboratory, National Oceanic and Atmospheric Administration, 325 Broadway, R/AL6, Boulder, CO 80305, United States

[2]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80305, United States

[3]Institute fur Physik der Atmosphare, Deutches Zentrum fur Luft and Raumfahrt, Wessling 82234, Germany

[4]Atmospheric Chemistry Division, National Center for Atmospheric Research, Boulder, CO 80307, United States

[5]Universidad Nacional Autonoma de Mexico, Centro de Cienceas de la Atmosfera, Ciudad Universitaria, Mexico DF 04510, Mexico

[6]Department of Meteorology, University of Utah, Salt Lake City, UT 84112, United States

[7]Atmospheric Research Project, Harvard University, Cambridge, MA 02138

[8]Department of Mechanical and Aeronautical Engineering, Clarkson University, Potsdam, NY 13699, United States

[9]Ames Research Center, National Aeronautics and Space Administration, Moffett Field, CA 94035, United States

[10]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, United States

The redistribution of HNO_3 via uptake and sedimentation by cirrus cloud particles is considered an important term in the upper tropospheric budget of reactive nitrogen. Numerous cirrus cloud encounters by the NASA WB-57F high-altitude research aircraft during CRYSTAL-FACE were accompanied by the observation of condensed-phase HNO_3 with the NOAA chemical ionization mass spectrometer. The instrument measures HNO_3 with two independent channels of detection connected to separate forward- and downward-facing inlets that allow a determination of the amount of HNO_3 condensed on ice particles. Subtropical cirrus clouds, as indicated by the presence of ice particles, were observed coincident with condensed-phase HNO_3 at temperatures of 197 K - 224 K and pressures of 120 hPa - 224 hPa. Maximum levels of condensed-phase HNO_3 approached the gas-phase equivalent of 0.8 ppbv. Ice particle surface coverages as high as 1.4x10 ^{14} molecules cm^{-2} (14% of a HNO_3 monolayer) were observed. A dissociative Langmuir adsorption model, when using an empirically derived HNO_3 adsorption enthalpy of -11.0 kcal mol^{-1}, effectively describes the observed molecular coverages to within a factor of 5. The percentage of total HNO3 in the condensed phase ranged from near zero to 100% in the observed cirrus clouds. With volume-weighted mean particle diameters up to 700 microns and particle fall velocities up to 10 m s^{-1}, some observed clouds have significant potential to redistribute HNO_3 in the upper troposphere.

A22A-1046 1330h POSTER

Measurements of Water Vapor and Total Water on the NASA WB-57: Validation and Determination of Cirrus Ice Water Content

Elliot M Weinstock[1] (617-495-5922; elliot@huarp.harvard.edu); Jessica Smith[1] (jxsmith@huarp.harvard.edu); David Sayres[1] (sayres@huarp.harvard.edu); Jasna Pittman[1] (vellovic@huarp.harvard.edu); James Anderson[1] (anderson@huarp.harvard.edu); Robert Herman[2] (rherman@mail2.jpl.nasa.gov)

[1](1) Department of Chemistry and Chemical Biology, Harvard University, 12 Oxford Street, Cambridge, MA 02138, United States

[2](2) Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, United States

We describe an instrument that makes accurate in situ measurements of total water. Cloud ice water content is determined using simultaneous water vapor measurements. The total water instrument integrates an aerodynamically shaped inlet and an in-stream heater with photofragment resonance fluorescence detection to quantitatively measure the total water content of ambient air. The air is isokinetically drawn into the instrument through the inlet positioned about a meter from the skin of the WB57 fuselage. The instrument detection axis is in principle identical to that in the water vapor instrument that has flown on the NASA ER-2 research aircraft since 1992. Ice water content measurements is critically important for: (1) determining effective ice densities as a function of ice particle size; (2) relating the microphysical properties of ice particles to their radiative properties; and (3) validating cloud ice water content measurements from remote and space-based instrumentation. We submit that validation of the total water measurements first requires validation of the instrument in clear air. We present validation data illustrating detailed in-flight intercomparisons with the Harvard and JPL water vapor instruments, and in-flight absorption measurements during the CRYSTAL FACE mission that illustrate instrument performance in clear air. Laboratory calibration procedures for it and the accompanying water vapor instrument are identical, and provide an accuracy of 5% for water vapor measurements. The close agreement between these three water vapor measurements on the WB57 helps provide convincing evidence of their accuracy, and has important implications for the upcoming validation plans for AURA instrumentation. We also discuss the uncertainties in the total water measurement caused by particle sampling issues, the possibility of incomplete particle evaporation, and instrument modifications to be implemented before the next mission. Data taken during a mission based out of San Jose Costa Rica in August 2001 and the CRYSTAL FACE mission based out of Key West, FL during July 2002 highlight instrument performance and illustrate instrument capability and the scientific utility of simultaneous measurements of water vapor and total water in the tropical tropopause layer.

A22A-1047 1330h POSTER

Impact of Nitric Acid on Cloud Microphysics and Climate

Huiwen Xue[1] ((303) 497 6567; huiwen.xue@noaa.gov)

Graham Feingold[1] (graham.feingold@noaa.gov)

[1]NOAA/ETL, 325 Broadway, Boulder, CO 80305, United States

Numerical simulation of cloud formation using an adiabatic cloud parcel model indicates that cloud droplet number concentration can be significantly increased when soluble trace gases, such as nitric acid, are present in the atmosphere. The increased number of cloud droplets may enhance the indirect climate forcing by aerosol. The growth of haze and cloud droplets by condensing water and nitric acid vapors on ammonium sulfate particles has been calculated explicitly using a kinetic droplet growth model. Results show that the effect of nitric acid is most significant when the updraft is weak. Because the transfer of water and nitric acid vapors to the growing droplets is a rate-limiting factor, we also investigated the sensitivity of cloud droplet number to different mass accommodation coefficients of water and nitric acid. It is found that for both water and nitric acid smaller mass accommodation coefficients can lead to more cloud droplets, including those that do not grow spontaneously but are large enough to have radiative effects. This is due to the fact that the partitioning of nitric acid among the gas and liquid phases depends on the number and sizes of the cloud droplets. Some of the cloud droplets may evaporate even after activation in a complex binary condensation and evaporation process. When the mass accommodation coefficients are small, the deactivation process becomes very slow and the droplets can remain large enough, and for sufficiently long enough, to have a radiative effect. We will present results that evaluate the importance of kinetic limitations on the transfer of soluble trace gases and explore the extent to which these affect aerosol indirect forcing on climate.

A22A-1048 1330h POSTER

Aerosol sources, absorption, and intercontinental transport: Synergies among models, remote sensing, and atmospheric measurements

Mian Chin[1] (301-614-6007; chin@rondo.gsfc.nasa.gov); Paul Ginoux[2] (pag@gfdl.noaa.gov); Oleg Dubovik[3] (dubovik@ltpmail.gsfc.nasa.gov); Brent Holben[1] (brent@spamer.gsfc.nasa.gov); Yoram Kaufman[1] (kaufman@climate.gsfc.nasa.gov); Allen Chu[4] (achu@climate.gsfc.nasa.gov); Tad Anderson[5] (tadand@atmos.washington.edu); Patricia Quinn[6] (quinn@pmel.noaa.gov)

[1]NASA GSFC, NASA Goddard Space Flight Center, Greenbelt, MD 20771

[2]NOAA GFDL, Forrestal Campus, Princeton, NJ 08542

[3]UMBC, NASA Goddard Space Flight Center, Greenbelt, MD 20771

[4]SSAI, NASA Goddard Space Flight Center, Greenbelt, MD 20771

[5]University of Washington, Department of Atmospheric Sciences, Seattle, WA 98195

[6]NOAA Pmel, NOAA Pacific Marine Environmental Laboratory, Seattle, WA 98115

Aerosol climate forcing is one of the largest uncertainties in assessing the anthropogenic impact on the global climate system. This uncertainty arises from the poorly quantified aerosol sources, especially black carbon emissions, our limited knowledge of aerosol mixing state and optical properties, and the consequences of intercontinental transport of aerosols and their precursors. Here we use a global model GOCART to simulate atmospheric aerosols, including sulfate, black carbon, organic carbon, dust, and sea salt, from anthropogenic, biomass burning, and natural sources. We compare the model calculated aerosol extinction and absorption with those quantities from the ground-based sun photometer measurements from AERONET at several different wavelengths and the field observations from ACE-Asia, and model calculated total aerosol optical depth and fine mode fractions with the MODIS satellite retrieval. We will also estimate the intercontinental transport of pollution and dust aerosols from their source regions to other areas in different seasons.

A22A-1049 1330h POSTER

Persistent Ice Supersaturation in Tropical Anvil Cirrus

Eric Jensen[1] (6506044392; ejensen@sky.arc.nasa.gov); Ann Fridlind[1] (fridlind@ice.arc.nasa.gov); Andrew Ackerman[1] (ack@fog.arc.nasa.gov); Leonhard Pfister[1] (pfister@mindego.arc.nasa.gov); Robert Herman[2] (Robert.L.Herman@jpl.nasa.gov); Thaopaul Bui[1] (pbui@mail.arc.nasa.gov); Darrel Baumgardner[3] (darrel@servidor.unam.mx); Paul Lawson[4] (plawson@specinc.com)

[1]NASA Ames Research Center, MS 245-4, Moffett Field, CA 94035, United States

[2]Jet Propulsion Laboratory, Mail Code 183-401 4800 Oak Grove Drive, Pasadena, CA 91109, United States

[3]Universidad Nacional Autonoma de Mexico, Centro de Ciencias de la Atmosfera Ciudaad Universitaria, Mexico, DF 04510, Mexico

[4]Spec, Inc., Suite B 5401 Western Avenue, Boulder, CO 80301, United States

During the 2002 Cirrus Regional Study of Tropical Anvils and Cirrus Layers - Florida Area Cirrus Experiment (CRYSTAL-FACE), the NASA WB-57 spent many hours sampling cloud microphysical properties, temperature, turbulence, and water vapor concentration within subtropical anvil cirrus. These measurements indicate that air within the cirrus is often substantially supersaturated with respect to ice, with average ice supersaturations increasing from about 5 to 30% as cloud temperature decreases from 220 to 195 K. The persistence of large supersaturations in cirrus with high ice crystal surface areas is unexpected. In this study, we examine the dependence of the measured anvil supersaturations on parameters such as ice water content, turbulence, anvil age, and temperature. We also use a three-dimensional cloud model that resolves the size distributions of cloud particles to investigate the physical processes responsible for the maintenance of ice supersaturation in anvils. The effects of radiatively driven turbulence, wave-driven temperature oscillations, and entrainment of ambient air will be discussed.

A22A-1050 1330h POSTER

Stochastic Climate Simulators for Diagnosing Regional Climate Variability and Model Physics

John W Bergman[1] (303 497-6076; bergmanj@colorado.edu)

Prashant D Sardeshmukh[1]

Cecile Penland[1]

[1]NOAA-CIRES Climate Diagnostics Center, 325 Broadway, Boulder, CO 80305-3328, United States

Atmospheric Single Column Models (SCMs) provide an economical modeling framework for diagnostic studies. In these models, vertical profiles of temperature and humidity evolve in response to diabatic interactions within the column and adiabatic tendencies produced by the large scale circulation. Often, physical parameterizations in the SCM are obtained directly from a general circulation model (GCM). This makes the SCM a valued resource for the development of comprehensive numerical climate forecast models. Typically in SCMs, the adiabatic tendencies are prescribed and, thus, decoupled from the diabatic tendencies. This decoupling can lead to the rapid development of atmospheric states that are not found in reality or in the corresponding GCM. This makes both the diagnosis of SCMs and its implications for GCM development difficult, it not impossible, to interpret. We have modified the SCM framework to include coupling between the adiabatic and diabatic tendencies. In this 'coupled' SCM, vertical temperature advection is parameterized in terms of the time-history of diabatic heating rates. The remaining adiabatic tendencies are then calculated under the additional assumption that the column is embedded in an uniform environment. This coupled framework stabilizes the SCM and allows the SCM to maintain a realistic climate, but damps out high frequency variability in long runs. To construct the 'stochastic climate simulator' (SCS), high frequency variability is introduced to the coupled SCM by adding multivariate red noise to the SCM tendency equation. The linear operator and white noise covariance for the stochastic forcing are calculated from error statistics gathered from short runs of the coupled SCM. This process exploits the stability of the coupled SCM and its near linearity for short integrations. When tested for tropical conditions, the resulting SCS produces realistic fluctuations of temperature and humidity compared to observations from TOGA COARE and maintains a stable climate in year-long runs. The SCS provides a economical diagnostic framework for extensive sensitivity testing. Furthermore, since we can construct SCSs from both observational data and GCM data, the SCS also provides an economical testing framework for GCM development.

A22A-1051 1330h POSTER

Ice Nucleation in Low-Temperature Aircraft Contrails During CRYSTAL-FACE

Robert L. Herman[1] (1-818-393-4720; robert.l.herman@jpl.nasa.gov); Andrew J. Heymsfield[2] (heyms1@ncar.ucar.edu); John K. Roskovensky[3] (jrosko@atmos.ucla.edu); K. N. Liou[3] (knliou@atmos.ucla.edu); Richard C. Miake-Lye[4] (rick@aerodyne.com); Michael D. King[5] (king@climate.gsfc.nasa.gov); Matthew J. McGill[5] (matthew.j.mcgill.1@gsfc.nasa.gov); T. P. Bui[6] (pbui@mail.arc.nasa.gov)

[1]Jet Propulsion Laboratory, California Institute of Technology, M/S 183-401, 4800 Oak Grove Drive, Pasadena, CA 91109, United States

[2]National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307, United States

[3]Department of Atmospheric Sciences, University of California, Los Angeles, 405 Hilgard Avenue, Los Angeles, CA 90095, United States

[4]Aerodyne Research Inc., 45 Manning Road, Billerica, MA 01821, United States

[5]NASA Goddard Space Flight Center, Code 900, Greenbelt, MD 20771, United States

[6]NASA Ames Research Center, M/S 245-4, Moffett Field, CA 94035, United States

Upper tropospheric ice clouds and aircraft condensation trails (contrails) were studied by both remote sensing instruments on the NASA ER-2 high-altitude aircraft and *in situ* atmospheric sampling instruments on the NASA WB-57F aircraft as part of the NASA CRYSTAL-FACE mission. During the Southern survey flights of July 9 and July 26, 2002, over the Caribbean Sea, non-persistent and persistent visible contrails were produced by the WB-57F aircraft and imaged by the MODIS Airborne Simulator (MAS), flying at higher altitude on the ER-2. These contrails were located in the vicinity of the local tropopause, where ambient temperatures were very low (minus 74 to minus 78°C). A consistent relation was found between contrail lifetime and ambient humidity, as measured by the JPL Laser Hygrometer (JLH) using temperatures from the WB-57F Meteorological Measurement System (MMS). We will discuss contrail physical properties in relation to nearby cirrus clouds, sensitivities of different MAS channels to contrail properties, *in situ* measurements of humidity and particles, and model simulations of ice nucleation and growth, and contrail dispersal.

A22A-1052 1330h POSTER

Small Scale Motions in Anvils During the CRYSTAL Florida Area Cirrus Experiment

Leonhard Pfister[1] (650 604 3183; lpfister@mail.arc.nasa.gov)

Paul Bui[1] (650 604 5534; pbui@mail.arc.nasa.gov)

Michael Poellot[2] (701 777 2184; poellot@aero.und.edu)

[1]NASA/Ames Research Center, Atmospheric Chemistry and Dynamics Branch, MS 245-5, Moffett Field, CA 94035-1000, United States

[2]University of North Dakota, Department of Atmospheric Sciences, Box 9006, Grand Forks, ND 58202, United States

Small scale motions in cumulus anvils are important because of their potential ability to transport heat, momentum, moisture, and ice. Also, the speed with which the turbulence decays may have an impact on the lifetime of ice particles. Finally, the strength of the small scale motions is an indication of how high the resolution of anvil models must be. The approach is to examine the vertical and horizontal velocity spectra, and vertical heat fluxes from anvil passes between 10-15 km during CRYSTAL-FACE from WB-57 and Citation aircraft. These can be compared with spectra from passes through major convective updrafts performed by a DC-8 aircraft during a different Florida convection experiment. Results for the WB-57 measurements show that: (1) small scale motions decay rapidly in the Florida anvils, the maximum power decaying by .5-1 decade per hour as the anvil ages; (2) spectra are quite steep in the anvil, with power decaying according to a -3 power law, in contrast to regions near the updraft where the power law is closer to -5/3; and (3) heat fluxes are mostly negative near the anvil tops, in contrast to the positive heat fluxes found during the active updrafts. The last result probably reflects the action of the turbulence in transporting air above the anvil (which has a substantially higher potential temperature than anvil air) downward into the anvil. Further work to be presented includes comparison with data from the Citation aircraft.

A22A-1053 1330h POSTER

Comparison of Cloud-Radiative Properties From Model Prediction and Satellite Retrievals during CRYSTAL-FACE

Donghai Wang[1] (d.h.wang@larc.nasa.gov)

Patrick Minnis[2] (p.minnis@nasa.gov)

Patrick W. Heck[3] (p.w.heck@larc.nasa.gov)

Louis Nguyen[2] (l.nguyen@nasa.gov)

David R. Doelling[3] (d.r.doelling@larc.nasa.gov)

[1]Hampton University, MS 420 NASA Langley RFesearch Center, Hampton, VA 23681, United States

[2]NASA Langley Research Center, MS 420, Hampton, VA 23681, United States

[3]AS&M, Inc., 1 Enterprise Parkway, Hampton, VA 23666, United States

To better understand the physical properties and formation processes of tropical cirrus/anvil clouds with a view toward the successful modeling of the Earth's climate, the CRYSTAL-FACE (Cirrus Regional Study of Tropical Anvils and Cirrus Layers - Florida Area Cirrus Experiment) field experiment took place over southern Florida from 1 July to 29 July 2002. During the entire field campaign, a very high-resolution numerical weather prediction (NWP) and assimilation system, ARPS (Advanced Regional Prediction System), was performed in support of the mission. ARPS is a multi-purpose modeling system capable of both data analysis/assimilation and multi-scale NWP ranging from cloud-scale to larger regional scale. The system has multi-nesting capability and contains detailed interactive physics for explicit cloud-resolving, land surface effect, cloud-radiation interactive transfer, cloud microphysics, and turbulence. In the real-time forecast, two nested 15/3 km grids are employed over the CRYSTAL-FACE experiment area. The 15-km grid covers the southeast US domain, and is run two times daily for a 36-hour forecast starting at 0000 UTC and 1200 UTC. The nested 3-km grid covering only southern Florida is used for 18-hour and 9-hour forecasts starting at 0600 and 1500 UTC, respectively. The forecast products were made available on the internet. The model predicts the 3-D cloud fields (cloud liquid water, rain water, cloud ice, snow and graupel/hail) and the associated radiative transfer properties, which can be used to characterize convection-anvils systems in dynamics and microphysics and their roles in both regional and global weather/climate. The satellite remote sensing retrieval using multispectral radiance data from the NOAA GOES satellite was used to provide satellite-derived cloud-radiative properties including cloud fraction, temperature, height, thickness, phase, optical depth, effective particle size and ice or liquid water path; and TOA fluxes and albedos. The preliminary results of the intercomparison show that the cloud fields from model and satellite-derived compare well, particularly for the frequency distributions of cloud ice water path. Those satellite-derived products will also be compared to the 4D higher-resolution (down to 1 km horizontal grid-size) data assimilation with insertion of the extensive experiment measurements, especially the NEXRAD radar and satellite data.

URL: http://asd-www.larc.nasa.gov/model/crystal

A22A-1054 1330h POSTER

Retrieval of Cloud Properties for Partially Cloud-Filled Pixels During CRYSTAL-FACE

Louis Nguyen[1] (l.nguyen@nasa.gov); Patrick Minnis[1] (p.minnis@nasa.gov); William L. Smith[1] (w.l.smith@larc.nasa.gov); Mandana M. Khaiyer[2] (m.m.khaiyer@larc.nasa.gov); Patrick W. Heck[2] (p.w.heck@larc.nasa.gov); Sunny Sun-Mack[3] (s.sun-mack@larc.nasa.gov); Taneil Uttal[4] (taneil.uttal@noaa.gov); Jennifer Comstock[5] (jennifer.comstock@pnl.gov)

[1]NASA Langley Research Center, MS 420, Hampton, VA 23681, United States

[2]AS&M, Inc., 1 Enterprise Pkwy, Hampton, VA 23666, United States

[3]SAIC, 1 Enterprise Pkwy, Hampton, VA 23666, United States

[4]NOAA ETL, 325 Broadway, Boulder, CO 80305, United States

[5]PNL, P.O. Box 999, MS K9-24, Richland, WA 99352, United States

Partially cloud-filled pixels can be a significant problem for remote sensing of cloud properties. Generally, the optical depth and effective particle sizes are often too small or too large, respectively, when derived from radiances that are assumed to be overcast but contain radiation from both clear and cloud areas within the satellite imager field of view. This study presents a method for reducing the impact of such partially cloud field pixels by estimating the cloud fraction within each pixel using higher resolution visible (VIS, 0.65mm) imager data. Although the nominal resolution for most channels on the Geostationary Operational Environmental Satellite (GOES) imager and the Moderate Resolution Imaging Spectroradiometer (MODIS) on Terra are 4 and 1 km, respectively, both instruments also take VIS channel data at 1 km and 0.25 km, respectively. Thus, it may be possible to obtain an improved estimate of cloud fraction within the lower resolution pixels by using the information contained in the higher resolution VIS data. GOES and MODIS multi-spectral data, taken during the Cirrus Regional Study of Tropical Anvils and Cirrus Layers - Florida Area Cirrus Experiment (CRYSTAL-FACE), are analyzed with the algorithm used for the Atmospheric Radiation Measurement Program (ARM) and the Clouds and Earth's Radiant Energy System (CERES) to derive cloud amount, temperature, height, phase, effective particle size, optical depth, and water path. Normally, the algorithm assumes that each pixel is either entirely clear or cloudy. In this study, a threshold method is applied to the higher resolution VIS data to estimate the partial cloud fraction within each low-resolution pixel. The cloud properties are then derived from the observed low-resolution radiances using the cloud cover estimate to properly extract the radiances due only to the cloudy part of the scene. This approach is applied to both GOES and MODIS data to estimate the improvement in the retrievals for each resolution. Results are compared with the radar reflectivity techniques employed by the NOAA ETL MMCR and the PARSL 94 GHz radars located at the CRYSTAL-FACE Eastern & Western Ground Sites, respectively. This technique is most likely to yield improvements for low and midlevel layer clouds that have little thermal variability in cloud height.

A22A-1055 1330h POSTER

The Statistical Nature of Heterogeneous Ice Nucleation: Laboratory Measurements with Volcanic Ash

Youshi Mi[1] (ymi@mtu.edu)

Raymond A Shaw[1] (906-487-1961; rashaw@mtu.edu)

[1]Department of Physics, Michigan Tech, 1400 Townsend Drive, Houghton, MI 49931, United States

Cirrus cloud processes (e.g., lifetime and radiative properties) are sensitive to the competing effects of heterogeneous and homogeneous ice nucleation. Tropical cirrus also may be affected by perturbations to the background aerosol, for example due to large volcanic eruptions. To this end, we have devised a laboratory experiment for studying the mechanisms of heterogeneous ice nucleation, with specific attention given to ice formation on volcanogenic particles. The statistical nature of heterogeneous ice nucleation can yield clues about the *physical mechanisms* responsible for ice formation. Using a laboratory system capable of measuring the freezing temperature for a single ice nucleus hundreds of times we have obtained detailed estimates of the probability density functions for freezing time (or temperature). We compare these pdf's to the 'idealized' case of an inhomogeneous Poisson process based on the classical model of heterogeneous ice nucleation. In addition, we are able to perform SEM analysis of each ice nucleus and thereby estimate the influence of properties such as surface area and morphology on the ice nucleation process. The laboratory measurements have implications for ice formation in volcanic clouds and volcanically-influenced cirrus clouds, as well as for the broader phenomenon of heterogeneous liquid-solid nucleation.

A22A-1056 1330h POSTER

Tracking Convective Systems in South Florida: Source of Cirrus Anvils

Paul A. Kucera[1] (701-777-6342; pkucera@aero.und.edu)

Todd Williams[1] (701-777-2184; todd.williams@und.nodak.edu)

[1]Department of Atmospheric Sciences, P.O. Box 9006 University of North Dakota, Grand Forks, ND 58202, United States

The Cirrus Regional Study of Tropical Anvils and Cirrus Layers - Florida Area Cirrus Experiment (CRYSTAL-FACE) field campaign provided a unique opportunity to study convective characteristics in South Florida. CRYSTAL FACE took place during July 2002. Four Weather Surveillance Radar - 1988 Doppler (WSR-88D) radars along with the NASA polarimetric (NPOL) 10 cm radar data were available during CRYSTAL FACE. The experiment provided a unique opportunity to study the evolution of convection and determine source regions of cirrus anvils in South Florida. The four WSR-88D and NPOL radar data were merged to provide a composite dataset of the radar echoes observed in South Florida. Radar echoes were tracked with time using cross correlation technique by determining the Lagrangian Autocorrelation between sequential radar observations. This analysis provides information about the mean wind fields and the initial source regions of the convection generating the cirrus anvils. A spectral decomposition of storm scales was applied to the dataset in efforts to gain a better understanding of the evolution of the convective systems at various storm scales. An overview of this study along with preliminary results will be presented in the poster.

A22A-1057 1330h POSTER

Formation of Anvil Ice Particles in a Deep Cumulus Updraft of CRYSTAL-FACE Simulated with an Explicit Microphysics Model - The Influence of Various Nucleation Processes

Vaughan T.J. Phillips[1] (609 452 6558; vtp@gfdl.noaa.gov); Steve Sherwood[2] ((203)432-3167; Steven.Sherwood@yale.edu); Aaron Bansemer[3] ((303)497-8913; bansemer@ucar.edu); William C. Conant[4] ((626) 395-3195; wconant@caltech.edu); Andrew Heymsfield[3] (303-497-8943; heyms1@ncar.ucar.edu); Gerry Heymsfield[5] ((301) 614-6369; heymsfield@agnes.gsfc.nasa.gov); Mike Poellot[6] ((701) 777-2184; poellot@aero.und.edu); Tim Vanreken[4] ((626) 395-3195; vanreken@caltech.edu)

[1]Princeton University/Geophysical Fluid Dynamics Laboratory (GFDL), P.O. Box 308, Princeton, NJ 08540, United States

[2]Geology Dept, Yale University, P.O. Box 208109, New Haven, CT 06520, United States

[3]NCAR/MMM, 3450 Mitchell Lane, PO Box 3000, Boulder, CO 80307-3, United States

[4]Department of Environmental Sciences and Engineering, California Institute of Technology, 210-41 Caltech, 1200 E California Blvd, Pasadena, CA 91125, United States

[5]Goddard Space Flight Center, NASA, Greenbelt,, MD 20771, United States

[6]Dept. of Atmospheric Sciences, University of North Dakota (UND), P.O. Box 9006, Grand Forks, ND 58202-9006, United States

Simulations of a cumulonimbus cloud observed by the Citation aircraft in the Cirrus Regional Study of Tropical Anvils and Cirrus Layers - Florida Area Cirrus Experiment (CRYSTAL-FACE) with an advanced version of the Explicit Microphysics Model (EMM) are presented here. Observations of the concentration of cloud condensation nuclei (CCN) by the Twin Otter aircraft in the planetary boundary layer are utilized to provide inputs to the model, together with measurements by the ER-2 and Citation aircraft. The interconnected mechanisms of secondary droplet nucleation and the warm rain process both combine to regulate the supercooled droplet concentration in the mixed phase region of the updraft, which determines the anvil ice concentration aloft. Perturbations in the turbulence enhancement coefficients for coalescence and in the CCN concentration are found to alter the properties of the anvil updraft because of their effects on the warm rain process. Homogeneous aerosol freezing can occasionally occur if the anvil ice concentration in parcels becomes very low.

A22A-1058 1330h POSTER

Deep convective cloud top heights during CRYSTAL-FACE

Steven C Sherwood[1] (203 432-3167; Steven.Sherwood@yale.edu)

Jung-Hyo Chae[1] (JungHyo.Chae@yale.edu)

Matthew McGill[2] (Matthew.J.McGill@nasa.gov)

Patrick Minnis[3] (p.minnis@nasa.gov)

[1]Dept. of Geology and Geophysics Yale University, PO Box 208109, New Haven, CT 06520

[2]Laboratory for Atmospheres, Code 912, Goddard Space Flight Center, Greenbelt, MD 20771

[3]MS 420, NASA/Langley Research Center, Hampton, VA 23681

We present comparisons between deep cumulus cloud top heights estimated by three methods during CRYSTAL-FACE: passive infrared radiance observed by GOES, the ER-2 CPL lidar, and MISR stereoscopic retrievals. We find that cloud top heights from GOES are somewhat underestimated. We also present a climatology of top heights by blending these platforms, obtaining thorough coverage from GOES but correcting the observations using discrepancies observed with colocated MISR (which has sparse sampling of all cloud types) and CPL (which has even more limited sampling, but highest accuracy) observations. Finally, we show that day-to-day variations in cloud top penetration over the Florida peninsula appear to be related to changes in CAPE, but that land-ocean and diurnal differences in cloud top penetrations cannot be explained by differences in CAPE.

A22B MCC: Level 2 Tuesday 1330h

Effects of Biomass Burning Plumes on the Troposphere and Stratosphere III Posters *(joint with B, AE)*

Presiding: **M Fromm,** Computational Physics, Inc.**; R B Chatfield,** NASA Ames Research Center

A22B-1059 1330h POSTER

Intercontinental Transport of Tropical Ozone from Biomass Burning - Views from Satellite and SHADOZ (Southern Hemisphere Additional Ozonesondes)

Anne M Thompson[1] (Anne.M.Thompson@nasa.gov)

Jacquelyn C Witte[2] (witte@gavial.gsfc.nasa.gov)

Robert B Chatfield[3] (chatfield@clio.arc.nasa.gov)

Hong Guan[3] (guan@clio.arc.nasa.gov)

[1]NASA/Goddard Space Flight Center, Mail Code 916, Greenbelt, MD 20771, United States

[2]Science Systems and Applications Inc., NASA/GSFC/Code 916, Greenbelt, MD 20771, United States

[3]NASA/Ames Research Center, SGG/MS 245-5, Moffett Field, CA 94035, United States

There has been interest in the connection between tropical fires and ozone since about 1980. Photochemically reactive gases released by fires (e.g. NO, CO, volatile organic carbon) interact as they do in an urban environment to form ozone. Interacting with chemical sources, tropical meteorology plays a part in tropospheric ozone distributions in the tropics, through large-scale circulation, deep convection, and regional phenomena like the West African and Asian monsoons. An overview of observations, taken from satellite and from ozone soundings, illustrates regional influences and intercontinental-range ozone transport in the tropics. One of the most striking findings is evidence for impacts of Indian Ocean pollution on the south Atlantic ozone maximum referred to as the "ozone paradox" [Thompson et al., GRL, 2000; JGR, 2003; Chatfield et al., GRL, 2003].

A22B-1060 1330h POSTER

Convective Lofting Links Indian Ocean Air Pollution to Recurrent South Atlantic Ozone Maxima

Robert B. Chatfield[1] (650-604-5490; chatfield@clio.arc.nasa.gov)

Hong Guan[2] (650-604-3903; guan@clio.arc.nasa.gov)

Anne M. Thompson[3] (301-614-5731; thompson@gator1.gsfc.nasa.gov)

Jacquelyn Witte[4] (301-614-6047; witte@gavial.gsfc.nasa.gov)

[1]NASA/Ames RC, MS 245-5, Moffett Field, CA 94035, United States

[2]NASA/Ames RC and BAER Institute, MS 245-5, Moffett Field, CA 94035, United States

[3]NASA/Goddard SFC, MS 916.0, Greenbelt, MD 20771, United States

[4]NASA/Goddard SFC and SSA Inc, MS 916.0, Greenbelt, MD 20771, United States

We extend on our analysis of equatorial tropospheric ozone to illustrate the contributions of South Asian pollution export in forming episodes of high O_3 over the Atlantic Ocean. We amplify on an earlier description of a broad resolution of the "Atlantic Paradox," for the Jan-Feb-March period, which included initial indications of a very long-distance contribution from South Asia. The approach has been to describe typical periods of significant maximum and minimum tropospheric ozone for early 1999, exploiting TOMS tropospheric ozone estimates jointly with characteristic features of the SHADOZ (Southern Hemisphere Additional Ozonesondes) ozone soundings. Further investigation of the Total Tropospheric Ozone (TTO) record for all of 1999 suggests that there are repeated periods of very long-distance Asian influence crossing Africa, with an apparent effect on those portions of the Atlantic Equatorial troposphere which are downwind. Trajectory analyses suggest that the pattern over the Indian Ocean is complex: a sequence invoving multiple or mixed combustion sources, low level transport, cumulonimbus venting, and high-level transport to the west seem to be indicated by the TTO record. Biomass burning, fossil and biofuel combustion, and lighting seem to all contribute. For the Atlantic, burning and lighting on adjacent continents as well as episodes of this cross-Africa long-distance transport are all linked in a coordinated seasonal march: all are related by movement of the sun. However, interseasonal tropical variability related to the Madden-Julian oscillation allows intermittent ozone buildups that depart from the seasonal norm.

A22B-1061 1330h POSTER

Emissions From Miombo Woodland and Dambo Grassland Savanna Fires in Southern Africa

Parikhit Sinha[1] (1-206-543-7238; psinha@atmos.washington.edu); Peter V. Hobbs[1] (1-206-543-6027; phobbs@atmos.washington.edu); Robert J. Yokelson[2] (1-406-329-4812; byok@selway.umt.edu); Donald R. Blake[3] (1-714-824-4195; dblake@orion.oac.uci.edu); Song Gao[4] (1-626-395-4635; sgao@caltech.edu); Thomas W. Kirchstetter[5] (1-510-486-5319; twkirchstetter@lbl.gov)